

Mitigating Interference from Unlicensed Devices in the TV Broadcast Bands Re: FCC NPRM ET Docket No. 04-186

Today's Presenters

- Ahren Hartman
Principal Engineer, Advanced Development
- Edgar Reihl, P.E.
Principal Engineer, Advanced Development
- Sandy Schroeder
Director, Corporate Market Development

Agenda

- Brief Introductions
- Purpose of Discussion
- Wireless Microphone Characteristics
- Interference Study Results
- Interference Mitigation Approaches
- Conclusions and Questions

Purpose of Discussion

Why are we here?

- FCC NPRM 04-186 would allow unlicensed devices to operate in “unused” TV channels. However, this spectrum is currently being used by wireless microphones.
- Shure is concerned that without a workable interference mitigation plan, these devices will cause major problems for wireless microphone users.
- ***Shure seeks the Commission's help in developing a set of rules and standards that will allow new unlicensed devices to share the TV spectrum without interfering with wireless microphones and wireless audio systems.***

Wireless Microphone Characteristics

What are wireless microphones, and how are they used?

- Wireless Microphones are part of a larger category of wireless audio products that also includes In Ear Monitors, wireless intercoms, and wireless cueing (IFB) systems.
- Wireless Microphones are essential to today's dynamic Radio and TV programming.
- Large productions like the Super Bowl, or a major political convention, require 50 –100 wireless audio channels to operate simultaneously.
- Because of their low power and mobility, wireless microphones require a known, stable spectrum environment to operate well.
- Professional users expect the highest sound quality from their wireless microphones.
- Users typically expect wireless microphones to last 7-10 years.

What are the basic technical characteristics of wireless microphones?

- Professional audio quality: 15 kHz audio BW, 100+ dB dynamic range
- Primarily analog FM
- Occupied bandwidth: 200 kHz
- Typical power: <50 mW ERP
- Working range: 100 meters

- Antenna diversity reception
- Secondary Users of Part 74 spectrum
- Classified as Low Power Auxiliary Stations

The NPRM suggested that interference to wireless microphones would not be a problem due to:

- Relatively high power output of up to 250 mW (UHF) and 50 mW (VHF)
- Relatively short working distances (300 ft.)
- Operation of FM "Capture Effect"

What are the problems with these assumptions?

- Almost all wireless microphones operate with 10-30 mW ERP due to battery life expectations and antenna efficiency. Lower power also promotes better spectrum efficiency.
- Obstructions and reflections can weaken wireless microphone signals even at short distances, such that the Desired-to-Undesired (D/U) signal ratio drops below minimum requirements for interference-free operation.
- The FM "Capture Effect" is far from complete.

Interference Study

- To determine the "real world" impact of unlicensed devices, Shure conducted an extensive interference study:
 - Recorded wireless microphone signal propagation inside a large arena at distances up to 300 feet at both VHF and UHF (over 2000 data points recorded).
 - Translated an 802.11g wireless LAN system into the UHF band and recorded conducted interference to a wireless microphone voice signal at various Desired/Undesired ratios.
 - Signal strength and audio quality were recorded.
 - Performed mathematical analysis demonstrating interference from unlicensed devices to wireless microphones in real-world applications.

The conclusion from the study is that it does not seem feasible to rely upon the ability of wireless microphones to overcome co-channel interference by means of "brute force", due of the fact that unlicensed device placement and operation will be relatively uncontrolled.

How could we avoid interference problems?

There are basically two approaches:

1. Lower the maximum allowed transmitter power of the unlicensed devices.
2. Utilize some type of frequency management scheme to prevent unlicensed devices from using the same TV channels as wireless microphones.

Interference Mitigation Approaches

What are some possible ways to prevent unlicensed devices from interfering with wireless microphones?

- Use a database with a control signal transmitted by a TV or radio station.
- Use "Listen Before Talk" (Dynamic Frequency Selection).
- Reserve some TV channels for wireless microphones in each market.

- Use wireless LAN devices to identify occupied TV channels to the wireless network.

What are the challenges with a database approach?

- The database would have to be updated continuously (not daily or weekly).
- Wireless microphone users would need a convenient way to input their data.
- The control signal would have to be able to regulate unlicensed device operation within a small zone, such as a building or a few city blocks.

What are the challenges with a “Listen Before Talk” approach?

- Wireless microphone users are mobile, and transmissions are not scheduled.
- Unlicensed devices would have to be able to detect comparatively weak wireless microphone signals (especially for Category 2 devices).
- Hidden node problems are likely.

What’s the Solution?

Shure recommends using a combination of the two remaining solutions:

- Set aside some TV channels for wireless microphone use in each market.
- Encourage unlicensed device manufacturers to work with the wireless microphone industry to develop networking protocols that would enable the use of a wireless LAN identification solution.

Allocating several reserved TV channels for wireless microphones in each market would be a workable solution:

- Reserved channel data could be sent via the control signal along with occupied TV data.
- Reserved channels could be changed when necessary due to TV channel changes.

What are the challenges with reserved TV channels?

- One or two reserved TV channels would be very inadequate for most wireless microphone users, due to technical and operational reasons.
- Reserved TV channels in both the VHF high band and the UHF band would be needed.

Why are more TV channels needed?

- Wireless microphone systems are only available in separate VHF and UHF models.
- Many installed systems are single frequency units.
- Synthesized systems typically tune over 18-30 MHz.
- Typical users require 16-20 wireless audio channels.
- With today’s systems, it is only possible to fit about 6-8 audio channels within one TV channel.

What does Shure recommend?

- In the near term, there should be two reserved VHF high band TV channels and 6 reserved UHF band TV channels.
- The reserved UHF TV channels should be grouped in three ranges with two non-contiguous channels in each range:
 - 2 channels in TV 22-27
 - 2 channels in TV 29-34
 - 2 channels in TV 43-48

Although reserved TV channels would address the needs of many wireless microphone users, there would not be enough spectrum for large events requiring 50 or more channels:

- To address these needs, a wireless LAN ID solution could be implemented.
- The wireless LAN ID solution relies on a combination of hardware and software.

How would wireless LAN identification work?

- Large wireless audio users would purchase a standard UHF band Wi-Fi LAN card (Category 1 device).
- The card could be installed in a PC or in a wireless audio transmitter or receiver designed to accept it.
- A software program would allow the LAN device to communicate with other locally-present Category 1 or Category 2 unlicensed devices to tell them what TV channels to avoid.

How would wireless LAN identification work for unlicensed devices?

- Local Category 1 and 2 unlicensed devices would need to detect the presence of the wireless audio system's Wi-Fi card and capture the occupied channel data from it.
- This is essentially a variation on the "beacon" concept that uses standard Wi-Fi hardware.

Wireless LAN identification has additional possibilities:

- A DTV receiver could be fitted with a Wi-Fi card to report to nearby unlicensed devices when it was being interfered with.
- This would allow automatic resolution of interference problems by "closing the loop" between the victim receiver and the transmitter.

Other possible interference mitigation techniques

Conclusions and Questions

What are the potential benefits of the above techniques?

- Wireless microphones can continue enabling dynamic broadcast Radio and TV programming without interference.
- The FCC succeeds in establishing new unlicensed spectrum in TV bands.
- Complaints from existing licensed wireless users about unlicensed devices are avoided.
- Unnecessary threats to a successful DTV rollout are minimized.

Shure supports the Commission's efforts to establish new unlicensed spectrum, as long as incumbent licensed broadcast TV and wireless audio users are protected from harmful interference. Shure seeks the Commission's help in formulating rules and standards that will enable this to happen.

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Edgar Reihl, P.E.